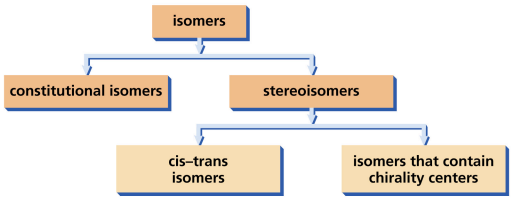
Chapter 5

Stereochemistry

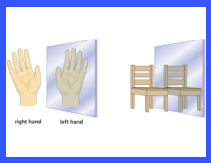
The Arrangement of Atoms in Space; The Stereochemistry of Addition Reactions



Molecular Chirality: Enantiomers

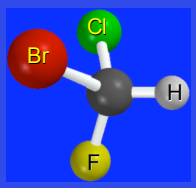
Chirality

A molecule is *chiral* if its two mirror image forms are not superimposable upon one another.

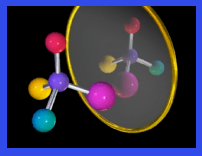


A molecule is *achiral* if its two mirror image forms are superimposable.

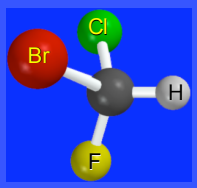
Bromochlorofluoromethane is chiral

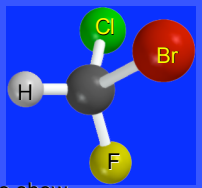


It cannot be superimposed point for point on its mirror image.



Bromochlorofluoromethane is chiral



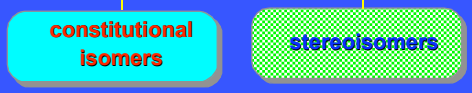


To show nonimsuperposability, rotate this model 180° around a vertical axis.

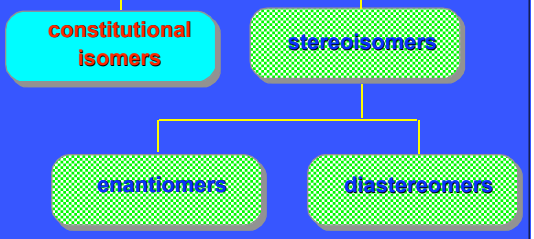
Enantiomers

Chirality & nonsuperimposable mirror images

Isomers



Isomers



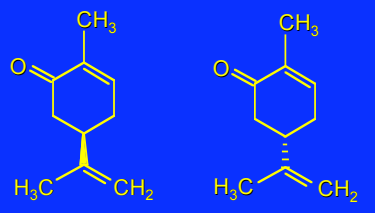
Physical Properties of Enantiomers

Properties of enantiomers

Physical properties are the same:
melting point, boiling point, density, etc

Some others are different:
properties that depend on the shape of molecule
eg. biological-physiological and optical properties.

Odor



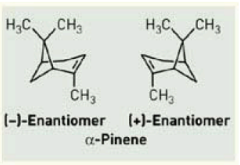
(–)-Carvone
spearmint oil

(+)-Carvone
caraway seed oil

Smells

Gall wasp larvae make the plants they eat alter the balance of (+) and (-) enantiomers of pinene; when they hatch the male wasps search out the plants with a different smell!

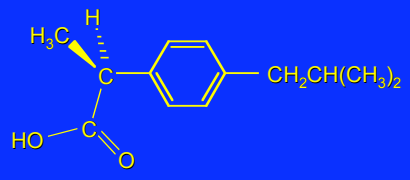
PHOTO BY JOHN TOOKER



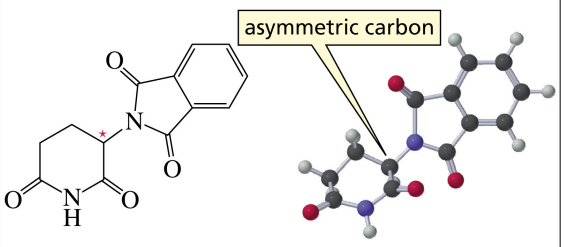
(–)-Enantiomer (+)-Enantiomer
α-Pinene

Chiral drugs

Ibuprofen is chiral, but normally sold as a racemic mixture. The enantiomer below is the one responsible for its analgesic and antiinflammatory properties.



A Sedative or a Potent Teratogen?



thalidomide

Thalidomide

Thalidomide was administered as a racemic mixture (50:50 mix of enantiomers) to stave off morning sickness during pregnancy.

The chiral carbon atom

a carbon atom with four different groups attached to it

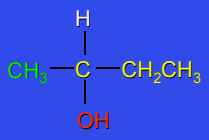
also called:

- chiral center; chiral carbon
- asymmetric center
- asymmetric carbon
- stereocenter
- stereogenic center

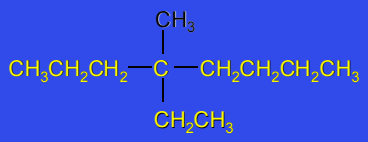
Chirality and chiral carbons

A molecule with a single stereogenic center is chiral.

2-Butanol is an example.



Examples of molecules with 1 chiral carbon

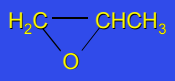


a chiral alkane

Examples of molecules with 1 chiral carbon

Linalool, a naturally occurring chiral alcohol

Examples of molecules with 1 chiral carbon

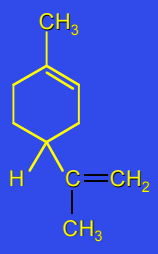


1,2-Epoxypropane: a chiral carbon can be part of a ring

attached to the chiral carbon are:

—H
—CH_3
—OCH_2
—CH_2O

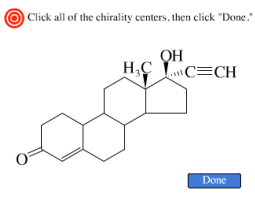
Examples of molecules with 1 chiral carbon



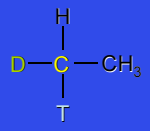
Limonene: a chiral carbon can be part of a ring

attached to the chiral carbon are:

—H
—CH_2CH_2
—CH_2CH=
—C=



Examples of molecules with 1 chiral carbon



Chiral as a result of isotopic substitution

A molecule with a single chiral carbon must be chiral.

But, a molecule with two or more chiral carbons may be chiral or it may not.

We'll return to this when we consider molecules with more than one chiral carbon atom.